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CHARACTERIZATION OF NATURAL AND DEPLETED URANIUM IN SEDIMENTS AND GROUND WATERS AT LAWRENCE LIVERMORE NATIONAL LABORATORY (LLNL) SITE 300, COAST RANGES, NORTHERN CALIFORNIA

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Since 1955, LLNL scientists have used depleted uranium, tritium, and thorium to a lesser degree, in explosives tests conducted at Site 300, an arid and rugged 11 mi^2 site, located 65 miles southeast of San Francisco. Site 300 is underlain by alluvium and Miocene volcaniclastic rock, some of which contains appreciable activities of natural uranium. Ground water flow occurs within pores and fractures and is influenced by faults that may create ground water barriers or preferential flow paths. Because the ground water at Site 300 is oxidizing and alkaline, it can dissolve uranium.

Debris from experiments was disposed in several unlined landfills. These landfills and the explosives test facilities (firing tables) are sources of depleted uranium to ground water. Natural uranium has a uranium mass ratio ($^{235}U/^{238}U$) of 0.0072; mass ratios below this value are indicative of depleted uranium.

By correlating the results of several characterization techniques, we have delineated: 1)several plumes of depleted uranium in ground water, 2)ground water containing elevated activities of natural uranium, 3)widespread low-moderate activities of depleted uranium in surface and shallow subsurface soil, and 4)stratigraphic intervals containing appreciable activities of natural uranium. We employed the following analytical techniques: atomic absorption flame spectroscopy, alpha spectroscopy, mass spectroscopy, and gamma logging using a sodium iodide crystal detector. Maximum activities of uranium detected in ground water, surface soil, and subsurface soil are about 100 pCi/L, 72 pCi/g, and 15 pCi/g, respectively. $^{235}U/^{238}U$ mass ratios in these three media range from 0.0017 to 0.0074.

Integration of the various techniques presented in this paper provided efficient and straightforward delineation of regions of Site 300 impacted by test debris, as opposed to natural sources. This integration also provides raw data for calculation of contaminant fate and transport and risk to human health and the environment, and determination of portions of environmental media at Site 300 that may require cleanup. We are continuing to evaluate this unique data set further in preparation for testing in-situ methods of immobilizing uranium in ground water.

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